NON-PUBLIC?: N
ACCESSION #: 9409260261
LICENSEE EVENT REPORT (LER)

FACILITY NAME: D. C. Cook Nuclear Plant - Unit 2 PAGE: 1 OF 4

DOCKET NUMBER: 05000316

TITLE: Unit 2 Reactor Trip on Low Feedwater Flow to Steam Generator #23 Coincident with Low SG Level as a Result of a Loss of Both Main Feedwater Pumps Due to Loss of Vacuum
EVENT DATE: 08/15/94 LER #: 94-005-00 REPORT DATE: 09/14/94

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 60

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: K. R. Baker - Operations TELEPHONE: (616) 465-5901
Superintendent

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On August 15, 1994 at 2350 hours with Unit 2 in Mode 1 at 60 percent Rated Thermal Power, Unit 2 received a reactor trip signal from a Steam Generator Number 23 Low Feedwater Flow Coincident with Low SG Level. At the time of the trip, the Control Room crew was in the process of removing the Number 21 Circulating Water (CW) Pump from service to troubleshoot a spurious low voltage alarm on the 4 KV bus. The closing of a CW pump discharge valve and stopping of the pump caused debris in the CW system to be stirred up and entrained in the cooling flow. The entrained debris then entered the Main feedpump turbine (FPT) condenser waterbox supply lines. The flow restriction in the FPT condenser waterboxes caused a rapid loss of vacuum and the West Main feedpump tripped on low vacuum. The reactor subsequently tripped on low feed flow coincident with low level on Loop 3.

The root cause of this event is attributed to zebra mussels within the Circulating Water system which temporarily blocked cooling flow through the main feedpump condenser water box tubes and caused a main feedpump trip on low vacuum.

After the reactor trip all safety systems operated normally and the reactor stabilized in Mode 3. The main feedpump condenser water boxes were cleaned and inspected and the reactor was returned to critical on August 16, 1994 at 2233 hours.

END OF ABSTRACT

Conditions Prior to Occurrence:

Unit 2 in Mode 1 (Power Operations) at 60 percent Rated Thermal Power in end of cycle coastdown.

Description of Event:

On August 15, 1994 Operations was supporting I&C in troubleshooting an alarm problem (EIIS/EA-ALM) on the 4 KV RCP bus. Operations was to stop and start the number 21 Circulating Water (CW) pump (EIIS/SG-P) while I&C observed selected relays believed to be part of the problem. The procedure for securing a CW pump instructs the operator to close the discharge valve and then immediately trip the pump. The discharge valve for the Number 21 CW pump was given a close signal, but after approximately 2 minutes the Control Room Balance of Plant (BOP) Operator had not yet received full closed indication. The normal stroke time for this valve is approximately 25 seconds.

Locally the valve appeared closed to the Auxiliary Equipment Operator (AEO). Believing the closed limit switch had not made up for the valve, the CW pump was tripped by the BOP Operator. High DP alarms were shortly received on the screen wash pump discharge strainer and FPT condenser waterboxes. The screens also tripped as designed on low screen wash pump discharge pressure.

After the pump was secured and prior to the feedpump (EIIS/SG-P) trip, it was noticed that the discharge valve for Number 21 CW pump was in an intermediate position and moving open. This caused a portion of the flow to bypass the condensers and produced reverse flow in the now idle CW pump. The discharge valve was given a STOP and then a CLOSE signal. After the valve was reclosed, main feedpump condenser (EIIS/SJ-COND)

vacuum continued to decrease and the Number 21 CW pump was restarted. The West main feedpump tripped approximately 10 seconds later on low vacuum.

Cause of Event:

The root cause of this event is attributed to zebra mussels within the circulating water system which temporarily blocked cooling flow to the main feedpump condenser water boxes and caused a main feedpump trip on low vacuum and a subsequent reactor trip on low feed flow coincident with low level on Loop 3. The zebra mussels were entrained in the cooling water due to a pressure and flow transient while removing the CW pump from service.

The feedpump condenser tubes are 3/4 inch diameter tubes, significantly smaller than the 1 1/8 inch main condenser tubes. Debris which passed through the feedpump and the main condensers would be discharged into a cross-tie pipe which supplies the screenwash pumps. The screenwash pumps discharge strainer is finer than the FPT condenser tubes, and would be plugged by the debris. High dP alarms were received on the screenwash discharge strainers shortly after the CW pump was initially secured. When later inspected, the strainers were found to be blocked by large numbers of mussels and the shear pin for the strainer had broken as a result of the number of mussel impacting the strainer. This plugging of the strainers supports the loss of CW flow due to zebra mussel entrainment as the root cause of the event.

Cause of Event: (continued)

In comparing the reduced CW flow and the debris effect in the CW system, recorders show the FPT condenser vacuum going to near zero over a 2 minute interval. The main condenser on the other hand, lost only an inch of vacuum, and showed only a half degree increase in CW temperature rise prior to the trip. Under any conditions, with the condenser water box valves full open the expected flowrate through of the main and the FPT condensers will be proportional to the square root of the dP across the condensers. The complete loss of vacuum on the FPT condensers is not characteristic of a reduction of CW system head, however, it is characteristic of a complete loss of cooling flow.

After the reactor trip, both feedpump turbine condenser high waterbox dP alarms remained standing, at twice the normal dP of 90 inches. Over the course of the next day, the FPT condenser waterbox differential pressures

gradually returned to normal.

As regards the CW pump discharge valve, it was determined that the valve received the open signal during the trip of the CW pump. The pump switch was turned from CLOSED, through AUTO and NEUTRAL to TRIP. When the switch passes through the AUTO position with the pump breaker closed, it generates an open signal to its discharge valve and caused the valve to open. Once full open, an automatic close signal to the valve was generated due to the CW pump being off, and the valve reclosed. The sequencing of the CW pump valve position changes may have negatively impacted the loss of flow transient cause by the zebra mussel blockage, but was ultimately only a contributor to the event.

Analysis of Event:

This event is being reported per 10 CFR 50.73 (a)(2)(iv) as an event that resulted in automatic actuation of Engineered Safety Features (ESF), including the Reactor Protection System (RPS).

A reactor trip occurred when a low feed flow coincident with low level on Loop 3 existed. All control rods fully inserted, the turbine tripped, both Motor Driven Auxiliary Feedwater Pumps started, and a feedwater isolation occurred; all as designed.

Normal offsite power was available, the emergency diesel generators were in standby, and no safety equipment was out of service prior to the trip. This event did not have any actual or potential adverse impact on the health and safety of the public.

Corrective Action:

The FPT condenser inlet waterboxes were removed from service for inspections the following day. The East feedpump waterbox revealed one clump of dead mussels, and approximately 30 pounds of mussels were removed. The West feedpump water box did not reveal significant mussel accumulation. The screenwash pump discharge strainers were checked for debris accumulation and found to be congested with large numbers of mussels.

Corrective Action: (continued)

The prevention of zebra mussels in the CW system has been an ongoing activity. Current strategies consist of injections of chemicals designed to kill zebra mussels in the forebay and intake tunnels, usually on a

yearly basis. Removal of the dead mussels is then performed by divers using a vacuum system.

Further preventive action includes the evaluation of circulating water and related systems so that an optimal solution can be implemented to eliminate mussel intrusion into those systems.

A procedure change for Operation of the Circulating Water System has been approved to provide additional guidance for the sequencing of valve operations when securing a CW pump.

Failed Component Identification:

NA

Previous Similar Events:

None

ATTACHMENT TO 9409260261 PAGE 1 OF 1

Indiana Michigan
Power Company
Cook Nuclear Plant
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Bridgman, MI 49106
616 465 5901 AEP

INDIANA
MICHIGAN
POWER

September 14, 1994

United States Nuclear Regulatory Commission
Document Control Desk
Rockville, Maryland 20852

Operating Licenses DPR-74
Docket No. 50-316

Document Control Manager:

In accordance with the criteria established by 10 CFR 50.73 entitled Licensee Event Report System, the following report is being submitted:

94-005-00

Sincerely,

A. A. Blind
Plant Manager

/sb
Attachment

c: J. B. Martin, Region III
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